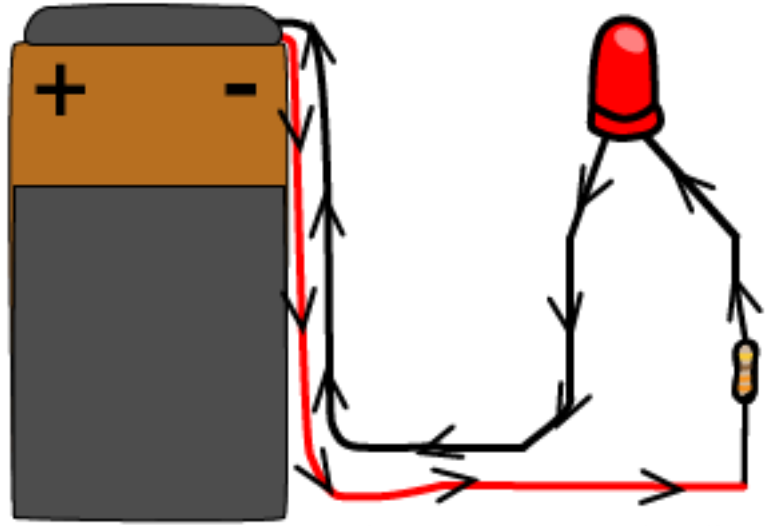
Dinesh Auti

Basics of Wearable Electronics

What is a Circuit?

- Combination of electronic parts, wires connected between power sources. It's like a physical program. It's also like setting up dominoes in sequence.



We can see here the flow of the circuit starts and ends at the power source

“Blinky, Festive, Elegant”

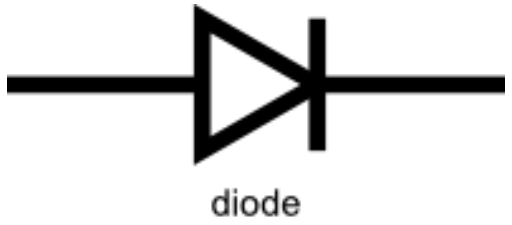
LEDs

What is an LED?

LEDs (that's "ell-ee-dees") are a particular type of diode that convert electrical energy into light. In fact, LED stands for "Light Emitting Diode." (It does what it says on the tin!)

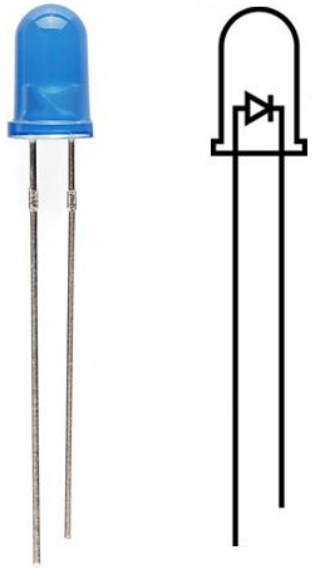
Basics

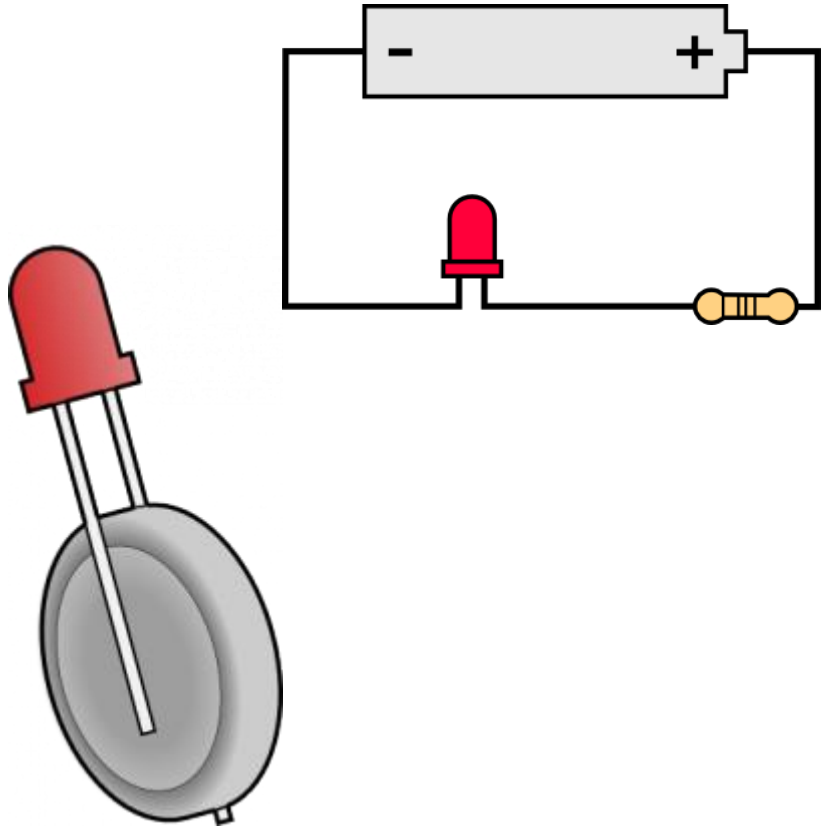
- Ohms Law
- LEDs require a lot less power to light up
- Polarity matters
- More current equals More light
- There is such a thing as too much power!



diode

light emitting diode





LEDs without Maths

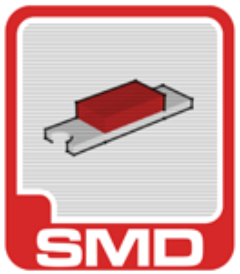
- A rule of thumb
- A battery, a resistor and an LED
- A good resistor value for most LEDs is 330 Ohms
- Connect all the components in series as shown
- Another way to light up an LED is to just connect it to a coin cell battery!

LEDs with Maths

- Of course, if you're not getting great results with the trial and error approach, you can always get out your calculator and math it up.
- LED Current
- LED Voltage
- LED Wavelength
- LED Brightness

ITEMS	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	20	mA
Peak Forward Current	I_{FP}	30	mA
Suggestion Using Current	I_{su}	16-18	mA
Reverse Voltage (V_R=5V)	I_R	10	uA
Power Dissipation	P_D	105	mW
Operation Temperature	T_{OPR}	-40 ~ 85	℃
Storage Temperature	T_{STG}	-40 ~ 100	℃
Lead Soldering Temperature	T_{SOL}	Max. 260℃ for 3 Sec. Max. (3mm from the base of the expoxy bulb)	

ITEMS	Symbol	Test condition	Min.	Typ.	Max.	Unit
Forward Voltage	V_F	I_F=20mA	1.8	---	2.2	V
Wavelenength (nm) or TC(k)	$\Delta\lambda$	I_F=20mA	620	---	625	nm
*Luminous intensity	I_V	I_F=20mA	150	---	200	mcd

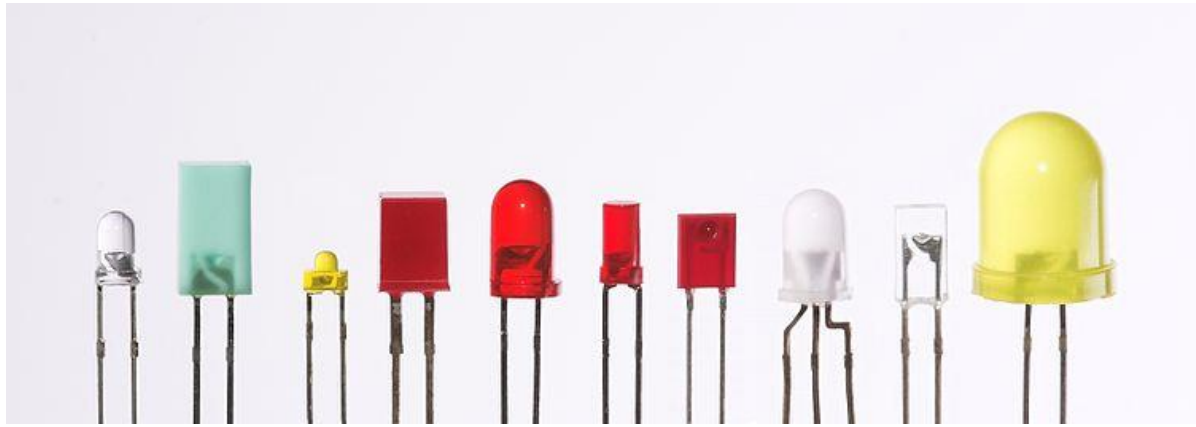

SMD

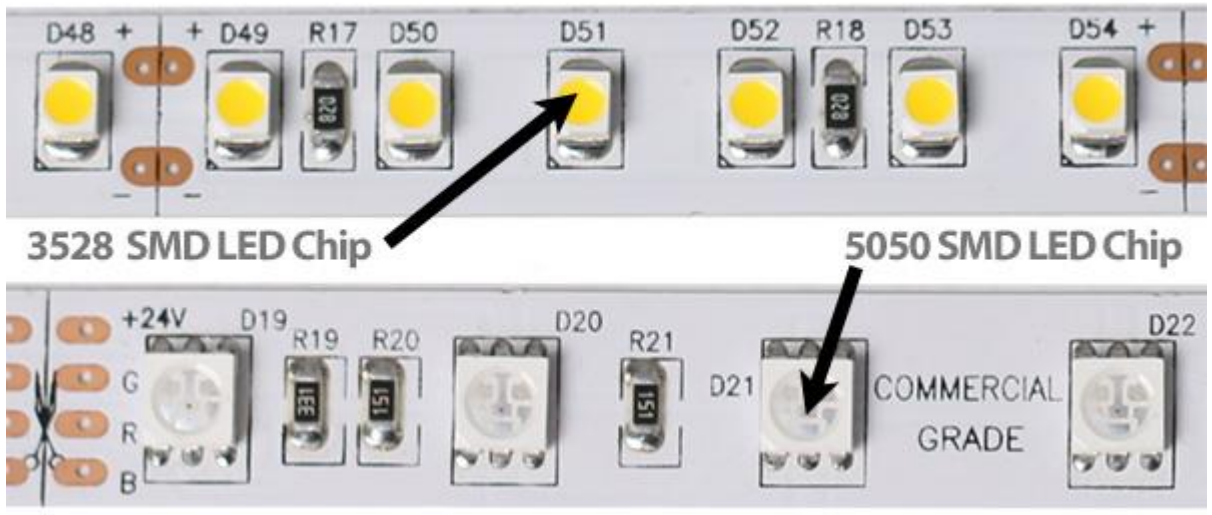
SPECIAL

RGB

High Power

Flashing




D48 +
+ D49
R17
D50
D51
D52
R18
D53
D54 +
3528 SMD LED Chip
5050 SMD LED Chip
+24V
D19
R19
R20
D20
R21
D21
D22
G
R
B
COMMERCIAL
GRADE

Demo!

"The Power!"

Battery

What is a Battery?

- Imagine a world where everything that used electricity had to be plugged in
- Battery to our rescue
- Chemical to Electrical
- Potential difference and Current
- With great power comes great responsibility!
- How Long Will My Project Run on Battery Power?
- Battery capacity is given in milliamp-hours (mAh)

Battery Capacity

- A typical LilyPad LED uses 20mA of current at full brightness
- A single LilyPad Pixel Board will use 40mA when it's set to white (all three internal LEDs fully on)
- Always consider the worst case!
- Hours = Battery mAh / Project mA
- Example - 110mAh battery - total hours?

	Number of LEDs	1	2	5	10	20
Battery Name	**Battery mAh**	**Hours of Operation**				
Polymer Lithium Ion Battery - 40mAh	40	1.3	0.8	0.4	0.2	0.1
E-Textiles Battery - 110mAh (2C Discharge)	110	3.7	2.2	1.0	0.5	0.3
Coin Cell Battery - 20mm (CR2032) *	250	8.3	5.0	2.3	1.2	.61
Polymer Lithium Ion Battery - 400mAh	400	13.3	8.0	3.6	1.9	1.0
Polymer Lithium Ion Battery - 850mAh	850	28.3	17.0	7.7	4.0	2.1
Polymer Lithium Ion Battery - 1000mAh	1000	33.3	20.0	9.1	4.8	2.4
Polymer Lithium Ion Battery - 2000mAh	2000	66.7	40.0	18.2	9.5	4.9
Polymer Lithium Ion Battery - 6Ah	6000	200.0	120.0	54.5	28.6	14.6

Example:
A project with 10 LilyPad LEDs controlled by a LilyPad Arduino

20mA * 10 + 10mA = 210mA

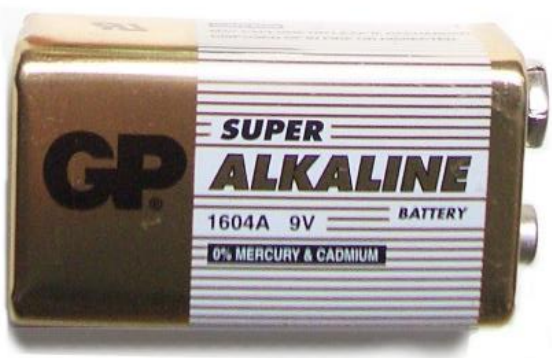
0.52 hrs = 110mAh / 210mA

653P652535 400mAh 3.7V

Panasonic
Made in Japan

FUJIFILM
EVEREADY

ALKALICELL


GP
SUPER
ALKALINE
1604A 9V
BATTERY
0% MERCURY & CADMIUM

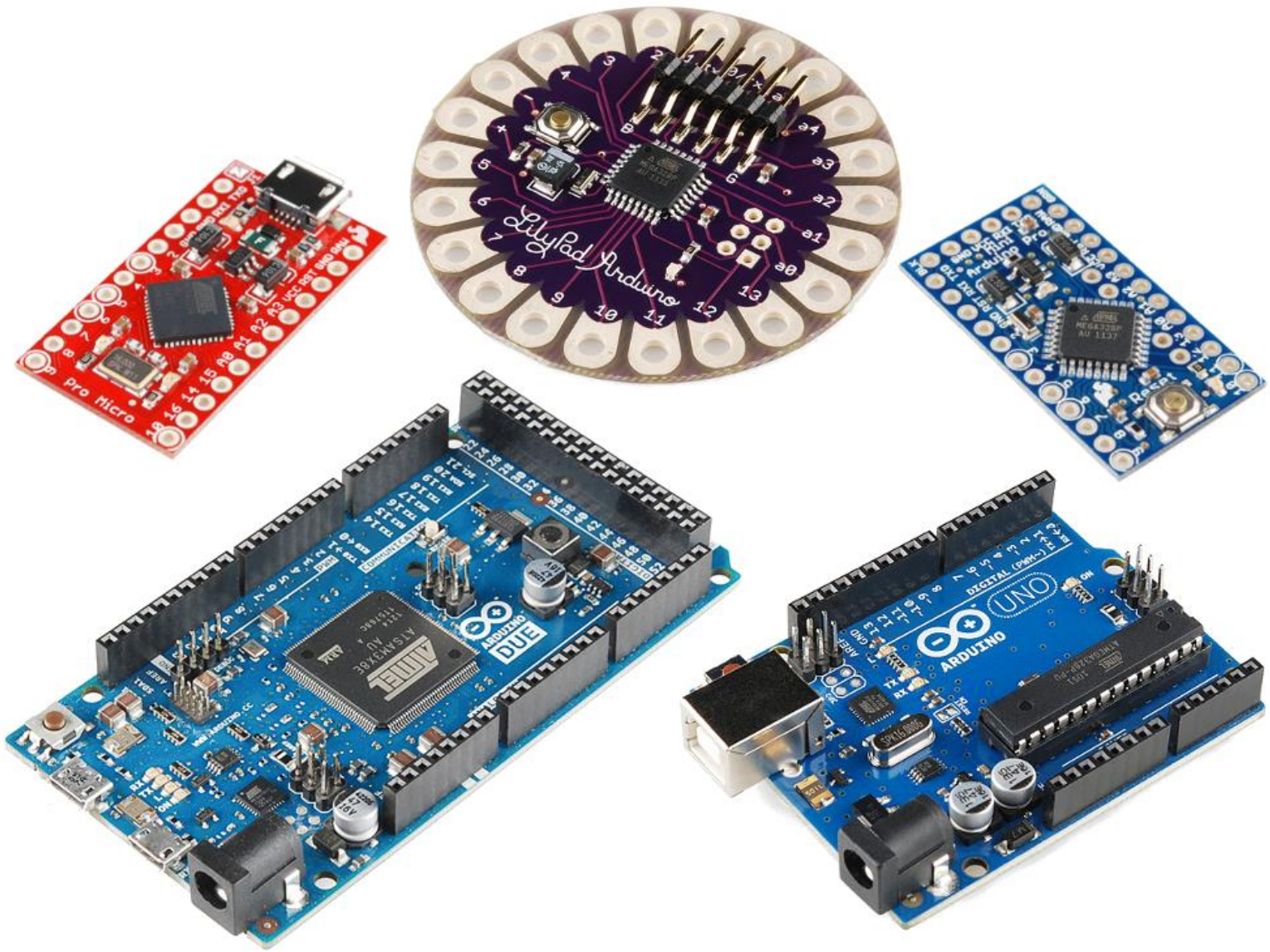
LI-ION RECHARGEABLE BATTERY
LIR2450
3.6V

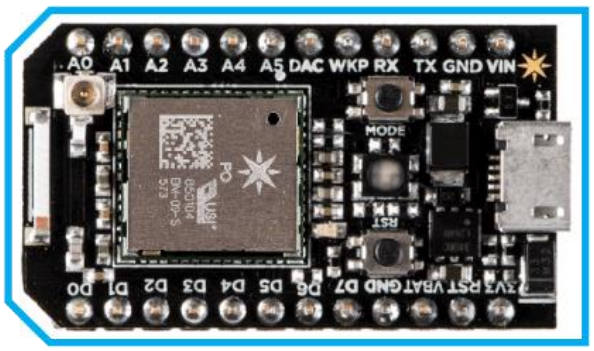
“The Brain”

Controller

What is a Controller?

- Acts as the brain
- Imparts smartness
- Entire computer on a single chip
- GPIO interface to the physical world
- Transducers/Sensors
- Need to write the software


Pro Micro
LilyPad Arduino
ARDUINO
DUE
UNO


A0 A1 A2 A3 A4 A5 DAC WKP RX TX GND VIN
MODE
RST
D0 D1 D2 D3 D4 D5 D6 D7 GND VBAT RST 3V3

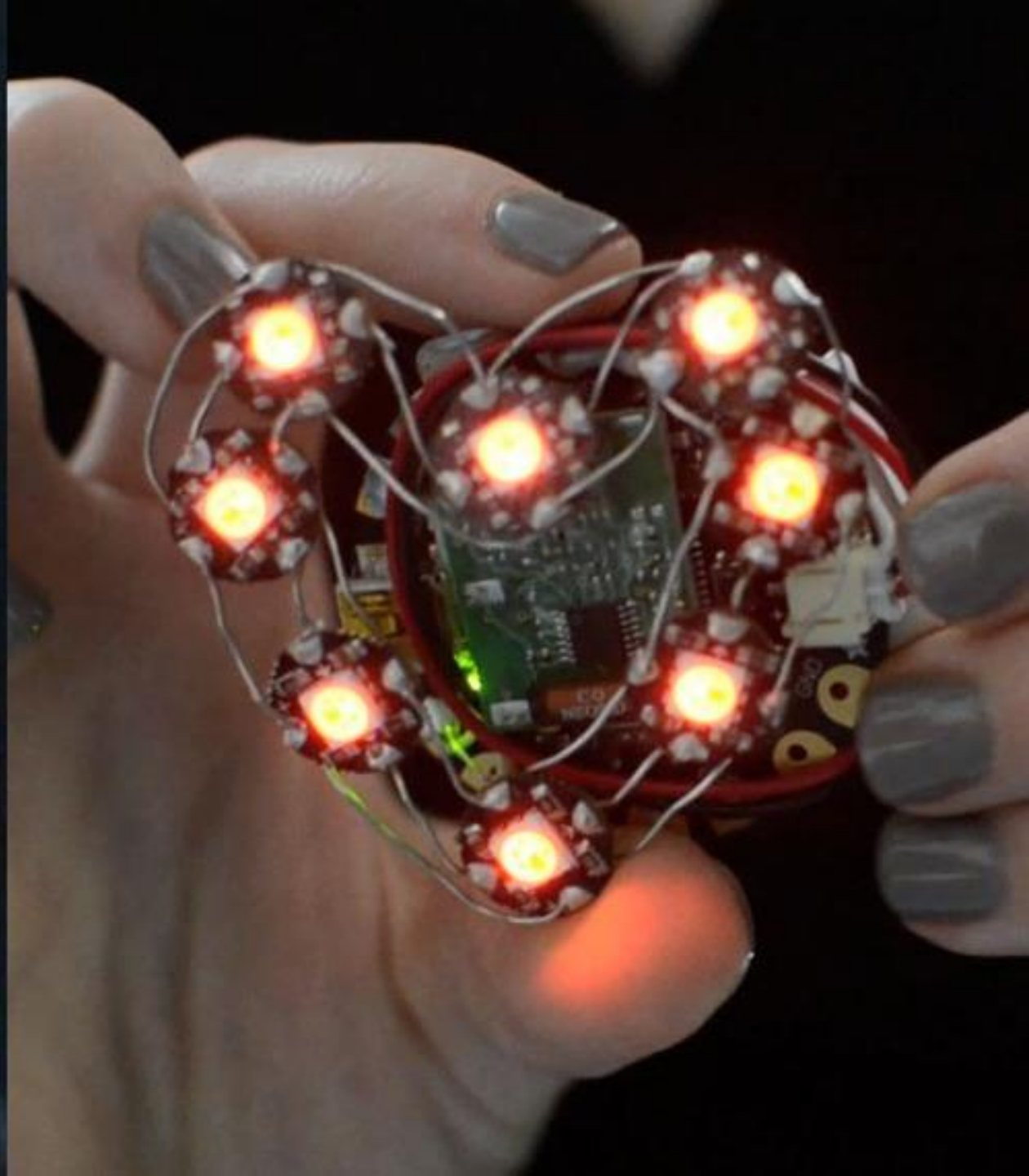
A11 A12 A13 RX TX GND VIN
SETUP
RST
3V3 RST VBAT GND D13 D12 D11
u-blox
13 14/36
00S-00
Model: SARA-U260
830000.0404.000
IMEI: 352252060748325
FCC ID: XPYSARAU260
IC: 8595A-SARAU260
Made in Austria

Demo!

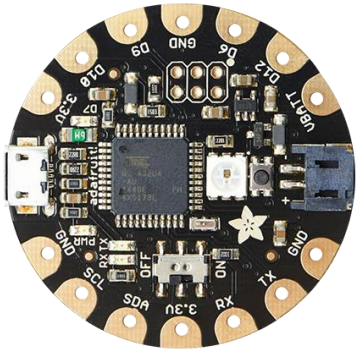
“Fashion meets Tech”

Wearables

NEVER



Demo!


GND
D9
D6
D12
D18
3.3V
VBATT
GND
SCL
SDA
3.3V
RX
TX
OFF
ON
PWR
RX TX

GSP652535 400mAh 3.7V

Credits

The content used to prepare these slides was taken from SparkFun and Adafruit.